

Capacity for Timber Management in Small and Medium Forest Enterprises: A Case Study from the Peruvian Amazon

Rosa E. Cossío · Stephen Perz · Karen Kainer

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Abstract With the implementation of a new legal framework for more responsible forest management in Peru, private small-medium forest enterprises (SMFEs) have become the most important social actors engaged in commercial forestry in the Peruvian Amazon. Despite the role of SMFEs in contributing to employment and local economic growth, there is little information with respect to their economic performance and capacities. This is a hindrance to efforts aimed at better characterizing this important sector and its influence on the development and conservation of tropical forests. For this study, 29 private SMFEs were surveyed to inventory their capital assets in order to evaluate their capacities to carry out timber management. Results indicate that SMFEs vary greatly in terms of their produced and natural capital assets, and consequently in their forest management capabilities as well. While most SMFEs lack adequate capacity for sustainable forest management, those that had more valuable timber resources and physical infrastructure attained forest certification. SMFE capacities depend greatly on external mechanisms to ensure consistent technical and financial assistance.

Keywords Forest management · Timber concessions · Small-medium forest enterprises · Capital · Amazon · Peru

R. E. Cossío (✉)

School of Natural Resources & Environment, University of Florida, 103 Black Hall,
P.O. Box 116455, Gainesville, FL 32611, USA
e-mail: cossior@ufl.edu; rosaecossio@gmail.com

S. Perz

Department of Sociology, University of Florida, Gainesville, FL 32611, USA

K. Kainer

School of Forest Resources & Conservation, University of Florida, Gainesville, FL 32611, USA

Introduction

Logging of natural forests is one of the most important economic activities in the humid tropics, generating significant revenues in many developing countries. However, conventional logging in the tropics has been predatory, causing considerable ecological damage and the loss of biodiversity and ecosystem functions (Johnson and Cabarle 1993; Putz et al. 2001). Because logging contributes to tropical deforestation and forest degradation, several international initiatives have sought to promote sustainable forest management (SFM). Consequently, some areas in the tropics have witnessed a transition away from predatory logging towards more responsible forest management. In the process, small and medium forest enterprises (SMFEs) have become important stakeholders of managed forests. Governments, non-governmental organizations (NGOs), and development agencies have all emphasized the role of small- and medium-sized enterprises due to their long history in serving as instruments for local economic development through the generation of wealth and employment (Kozak 2007). SMFEs thus represent an established model now being applied to the forestry sector in the hopes of combining economic development with SFM.

SMFEs are forestry businesses that operate with 10–100 full-time employees and/or have yearly operating budgets of US\$10,000 to US\$30 million (Macqueen 2007). SMFEs may involve private or community-based enterprises. SMFEs differ from community forest management because SMFEs are business operations aimed at making a profit from forest related activities, while community forest management does not necessarily involve a business operation aimed at making only a profit to take place, and involves also social and environmental objectives. SFMEs may be private enterprises or community-based; while some are formally-constituted, many operate informally. Private SMFEs hold exclusive access rights to forest resources and are governed by rules defined by business partnership contracts. Community-based enterprises hold collective rights and their governance depends on local/communal rules based on customary practices, but in SMFEs enforcement is overseen by SMFE management.

Overall, SMFEs constitute a growing segment of the forestry sector since they encompass 80–90% of forest sector operations in many countries, and they contribute significantly to local employment and economic growth (Macqueen 2008). SMFEs are often embedded in local cultures, which is beneficial for both the enterprise and the community. For example, SMFEs secure resource rights and access to local peoples as a function of their proximity to local communities, which in turn benefit by accumulating wealth locally through employment in SMFEs and the subsequent improvement of rural people's livelihoods (Auren and Krassowska 2004; Macqueen 2008). SMFEs also have a greater commitment to operating in a specific area than do large-scale enterprises (Macqueen and Mayers 2006; Macqueen 2008). Thus, SMFEs are important for the sustainability and viability of forest dependent communities around the world (Kozak 2007).

Although prior publications have emphasized the potential of SMFEs to harmonize employment growth and local development with conservation goals, there is little empirical documentation of SMFE capacity for sustainable forest

management (Macqueen and Mayers 2006). While much is known about the capacities of communities and larger-scale timber enterprises, it remains an open question as to the capacity of SMFEs to engage in SFM in their concession areas. The informality of many SMFEs has resulted in a gap in the availability of information in many countries with respect to their assets, management practices, and economic performance, which are crucial elements that determine SMFE capacity for SFM (May et al. 2003; Saigal and Bose 2003; Thomas et al. 2003; Kozak 2007). In Brazil, limitations and contradictions in available studies have made SMFEs there difficult to evaluate (May et al. 2003). These issues hinder an adequate understanding of SMFEs and their influence on local development and conservation of tropical forests relative to communities, large timber enterprises, and other traditional concessionaire models.

In the Peruvian Amazon, one of the mega-diverse regions in the world, private SMFEs have become the main actors in the management of the permanent production forests granted as long-term forest concessions. This occurred after enactment of Peru's 2000 Forestry and Wildlife Law (Nº 27308) which created a new legal framework for responsible forest management and social development. Despite the vital role SMFEs play in the management of Peruvian forests, particularly after decades of forest overexploitation and degradation, there is little documented information regarding SMFE capacities and performance regarding SFM. Given the numerical importance of SMFEs in the Peruvian forestry sector and the paucity of information about SMFEs in general, it is important to empirically assess SMFEs in order to understand their capabilities with respect to SFM, which in turn bears implications for forest conservation.

We report the results of a census of private SMFEs engaged in timber management in the southeastern Peruvian Amazon. We address the question of the extent to which different capital assets differentiate among SMFEs in the southeastern Peruvian Amazon, and how those assets influence their forest management relative to that prescribed by Peru's Forestry Law. We pursue our analysis through a comparison of SMFEs in provinces of the study area with differing histories of timber exploitation.

Theoretical Framework

We adopt a “capitals and capabilities” framework (Bebbington 1999) to evaluate the management performance of SMFEs. “Capital” refers to the stock of goods that can produce further goods or utilities in the future (Hinterberger et al. 1997). Various productive assets (types of capital) are very important for evaluating the capabilities of enterprises, communities, and households to pursue livelihood strategies. Capital scarcity amounts to an “internal limiting factor” on the capacity to generate wealth while sustainably managing resources. A comprehensive inventory of SMFE capitals therefore, provides a basis for evaluating SMFE performance in terms of economic considerations such as employment generation as well as the sustainability of forest management practices. Thus, capital theory is

useful for present purposes because it specifically focuses on the productive assets needed by SMFEs to pursue their livelihoods and achieve SFM.

There are four different categories of capital in economic analysis: physical, natural, human, and social (Coleman 1988; Serageldin and Steer 1994; Uphoff 2000). Table 1 presents these dimensions of the capitals framework along with indicators of each dimension. We draw on the DFID livelihood framework (Department for International Development 1999) and the Social Capital Assessment Tool (SOCAT), an instrument of the Social Capital Initiative by the World Bank (Grootaert and Bastelaer 2002) to identify relevant indicators for each dimension of capital.

The Livelihood Framework (Department for International Development 1999) subdivides the traditional category of physical capital into two distinct categories: physical and financial capital. In other livelihood frameworks, physical and financial capitals are combined and referred as produced capital (Scoones 1998; Serageldin and Steer 1994). Produced capital is comprised of the manufactured, constructed and financial resources such as roads, tools, vehicles, machinery, credit, etc. (Serageldin and Steer 1994; Department for International Development 1999). Indicators of physical capital for SMFEs include the value of key investments for timber harvesting: harvesting equipment (chainsaws, skidders, trucks), roads, harvesting fees, and management plans, plus the value of loans/credit and the areas of forest concessions.

Natural capital is usually defined as any stock of natural resources or environmental assets such as soils, forests, water, etc. (De Groot et al. 2003; Scoones 1998). For purposes of evaluating SMFE capabilities, the key indicators of natural capital include the approved and actual harvested timber volumes of key timber species, ranging from high- to lower-value species.¹

Human capital is composed of the skills and experience of individuals which are in large part the product of broader investments in education and training (Coleman 1988; Chhibber 2000). For SMFEs, we evaluate human capital via the total number of enterprise members, enterprise members with previous logging experience, enterprise members with previous business experience, and the educational attainment of the SMFE manager. These indicators encompass measures not only of individual (manager) human capital but also the human capital of the SMFE overall.

Social capital refers to features of social organization that facilitate coordination and cooperation in order to improve efficiency (Putnam 1995; Grootaert and Bastelaer 2002). Because SMFEs are collective enterprises, social capital is key to their overall productive capacity. We therefore, employ several measures of social capital, derived from both network- and trust-based statements on social capital. Network measures include the number of forest associations to which a SMFE belongs, the number of people outside the SMFE who provide financial assistance, and a scale of exclusion of people from the SMFE for one reason or another.

¹ The two indicators of natural capital that we consider for analysis (i.e., approved timber volume and harvested timber volume) are sub-divided into the five categories of timber species according to their commercial value established by Peruvian Ministerial Resolution N° 0245-2000-AG.

Table 1 Capital indicators evaluated in Madre de Dios

Indicators	Definition
<i>Produced capital</i>	
Equipment	Actual value in US\$ of useful equipment owned by the SMFE during Harvest 2006
Roads	Value in US\$ of roads constructed by the SMFE until Harvest 2006
Harvesting fee	Value in US\$ of accumulated annual harvesting fee (a fee in US\$/ha for all the concession area) of the SMFE until Harvest 2006
Loan	Amount in US\$ received as credit per SMFE until Harvest 2006
Management plans	Value in US\$ of all annual operating plans approved to SMFEs until Harvest 2006
Area	Total concession area in hectares
<i>Natural capital</i>	
Approved timber volume	Total volume of timber in m ³ /ha approved by INRENA until Harvest 2006
A category	Total approved volume (m ³ /ha) of mahogany
B category	Total approved volume (m ³ /ha) of cedar
C category	Total approved volume (m ³ /ha) of timber species of “intermediate value” (e.g., <i>Cedrela catenaeformis</i> , <i>Amburana cearensis</i> , <i>Chorisia</i> sp., <i>Aniba</i> sp., <i>Virola</i> sp.)
D category	Total approved volume (m ³ /ha) of timber species with “potential value” (e.g., <i>Dipteryx odorata</i> , <i>Tabebuia</i> sp., <i>Coparia officinalis</i>)
E category	Total approved volume (m ³ /ha) of “other” timber species (e.g., <i>Hymenaea</i> spp., <i>Myroxylon balsamum</i> , <i>Manilkara bidentata</i> , <i>Couratari guianensis</i>)
Harvested timber volume	Total volume of timber in m ³ /ha that has been harvested by SMFEs during the Harvest 2002–2006
A category	Total harvested volume (m ³ /ha) of mahogany
B category	Total harvested volume (m ³ /ha) of cedar
C category	Total harvested volume (m ³ /ha) of timber species of “intermediate value”
D category	Total harvested volume (m ³ /ha) of timber species with “potential value”
E category	Total harvested volume (m ³ /ha) of “other” timber species
<i>Human capital</i>	
Enterprise members	Total number of members in SMFEs during Harvest 2006
Logging experience	Total number of members in a SMFE during Harvest 2006 with previous experience in logging (before SMFE formation)
Business experience	Total number of members during Harvest 2006 with previous experience in business (before SMFE formation)
Education	Manager’s education; measured as the number of completed schooling years
<i>Social capital</i>	
Density of membership	Number of forest associations a SMFE belongs to. It is the percentage of SMFEs belonging to none, 1, and 2 + associations
Networks	Percentage of the existence of people outside the enterprise and/or institutions assisting a SMFE for financial and commercial purposes. 100 is the highest possible value.
Exclusion	Percentage of the existence of exclusion among enterprise members due to characteristics such as education, wealth, and political ideas. 100 is the highest possible value
Trust	Percentage of the extent of trust among enterprise members overall. 100 is the highest possible value

Table 1 continued

Indicators	Definition
Participation	Percentage of membership participation in meetings and in general in enterprise activities. 100 is the highest possible value

Measures of trust include a scale of trust among SMFE members and the percentage of SMFE members who participate in SMFE meetings.

Given the existence of different dimensions of capital, it is necessary to consider each in an analysis of the capacity of SMFEs for forest management. Exclusion of a type of capital may result in oversights concerning management capacity, particularly if that type of capital is limited and thereby hampers effective management. A thorough capitals inventory is especially important for the case of SMFEs since their capital assets are not well documented.

Methods

Study Area

This study was conducted in the Department of Madre de Dios, one of the main centres of timber production in Peru. Madre de Dios is where the forest concession system was first implemented as the new model for Peruvian forest management in 2002. Consequently, Madre de Dios is currently being considered as a model for implementation of this system in the rest of Peru. Madre de Dios is situated in the southeastern Peruvian Amazon (Fig. 1) and is the third largest Department in Peru in terms of area (85,300.54 sq. km). Madre de Dios comprises the provinces of Tahuamanu, Tambopata, and Manu, which cover two biophysical units: (1) the *Cordillera Oriental Faja Subandina* (500–3,967 masl) in the southwest of the department, a ruggedly mountainous region comprised of shallow soils of low natural fertility, and (2) the *Llanura de Madre de Dios*, (176–500 masl) which is the more extensive of the two units, with a soft and undulating relief where floodplains and low hills are predominant. In that zone, the soils are deep, being floodplains of high fertility (INEI 2004). Rainfall in the department averages 2,260 mm year⁻¹, concentrated in a rainy season from October to April. The annual average temperature in Puerto Maldonado is 26°C (INEI 2004).

Madre de Dios is a mega-diverse zone (Myers et al. 2000) with world records for bird, insect, and mammal biodiversity (Huertas Castillo 2004). This high biodiversity prompted the creation of various protected areas which comprise 4.7 million hectares (55.1% of the department area) and encompass 50% of the Peruvian diversity and endemism, making Madre de Dios “the biodiversity capital of Peru” (CTAR-Madre de Dios and IIAP 2000). The region is also home to 9 ethnic groups of Amazon Indians (Huertas Castillo 2004). The rural non-indigenous population is settled in small subsistence communities along rivers and roads, with

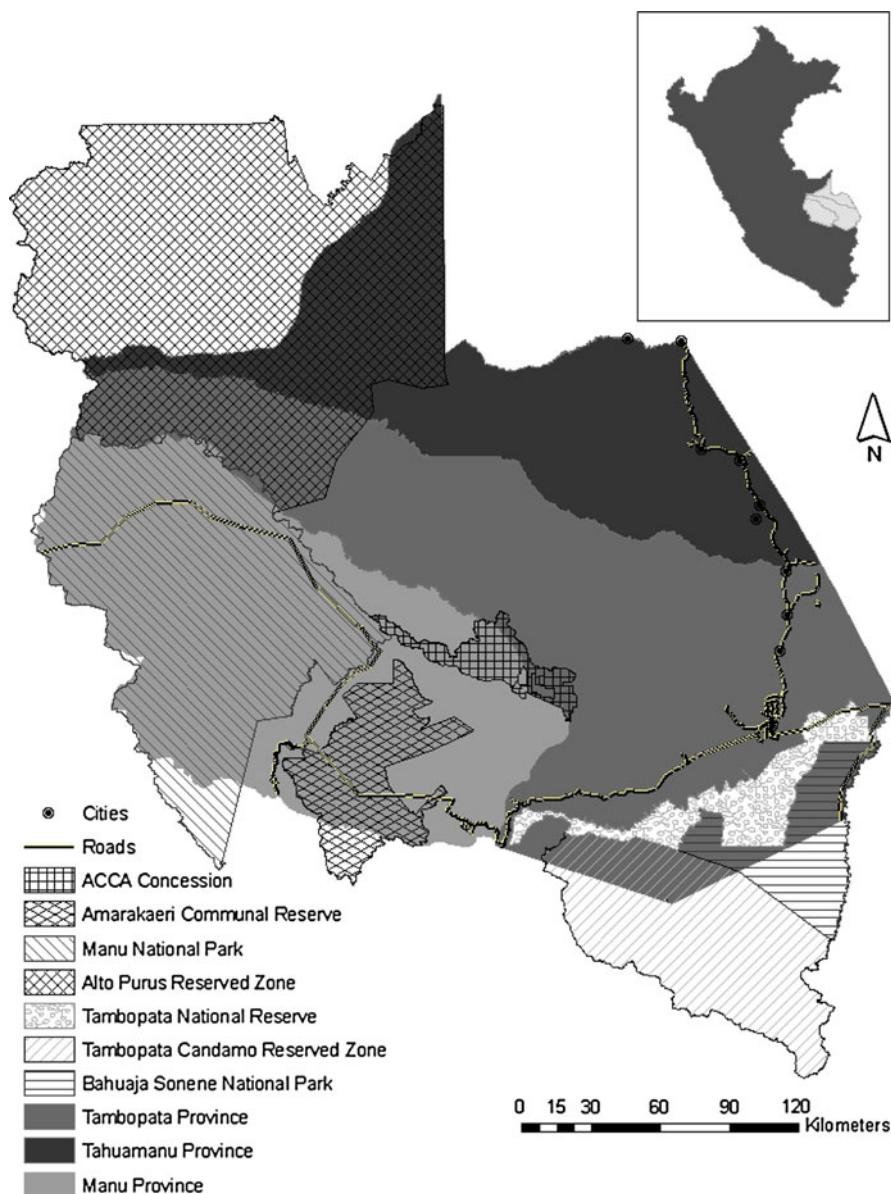


Fig. 1 Map of Madre de Dios protected areas. It shows protected areas that fall partly or entirely within Madre de Dios (elaborated by Andrea B. Chavez)

producers engaged in a mix of agricultural and extractive activities, including Brazil-nut harvesting, gold mining, fishing and logging (Chirinos and Ruiz 2003).

Logging is one of the most important activities in Madre de Dios, employing 65% of the economically active population. Traditionally, the three most valuable timber species have been harvested: mahogany (*Swietenia macrophylla*), cedar

(*Cedrela odorata*), and “tornillo” (*Cedrelinga catenaeformis*). Together they represent almost 60% of the total volume harvested in Madre de Dios (Chirinos and Ruíz 2003).

Since implementation of the new forest concession system in 2002, private SMFEs started managing the permanent production forests of Madre de Dios for timber production. Most of these private SMFEs derived from pre-existing associations (i.e., small loggers and neighbors), with a few enterprises formed among family members, and a similarly small number constituted by an individual. Most of the private SMFEs in Madre de Dios (78%) are formed by migrants mainly from Cusco (a neighboring Department) who had resided in Madre de Dios for an average of twenty-six years. SMFEs in Madre de Dios harvest on average seven commercial timber species per year. Although mahogany and cedar are still the two most valuable and harvested timber species in the Department, more commercial species have been harvested since 2002 including *Cedrelinga catenaeformis*, *Amburana cearensis*, *Aspidosperma macrocarpon*, *Dipteryx alata*, and *Tabebuia* sp, among others. This has occurred mainly due to rising prices and demand for less traditional timber species (Cossío 2009).

Logging has historically differed among the three provinces of Madre de Dios. As a reflection of the pattern of settlement in the southeastern Peruvian Amazon, which largely occurred via migration down from the Andes along rivers in the southern portion of the department, logging historically occurred largely in the provinces of Manu and Tambopata. With the paving of the Inter-Oceanic Highway in more recent years, logging and other settlement activity has proceeded northward into Tahuamanu province. Consequently, at the time of Peru’s new forestry law, forests in Manu and Tambopata were relatively depleted of high value timber species such as *Swietenia macrophylla*, which remained in Tahuamanu, where SMFEs emerged to take advantage of the remaining high-value stocks. These differences in natural capital beg questions about provincial variations in other SMFE capitals and the ramifications for SMFE ability to manage their concessions.

Survey Techniques

Data were gathered in a survey of 29 private SMFEs² in all three of the provinces of Madre de Dios between June and August 2007. This study focuses on the population of private SMFEs where forest concessions were granted in the first round of public bidding in 2002. The emphasis on concessions from the first round is important because they represent 85.4% of the total area of the permanent production forests currently granted in the Department; thus, these enterprises will determine the outcome of most forest management in Madre de Dios. However, 9 SMFEs were not included because their managers declined interviews or the managers and/or members could not be located during the period of the study.

The survey was based on structured interviews in which SMFE managers were interviewed about the forms of capitals (i.e., produced, natural, human, and social)

² Of the 29 SMFEs, there are actually only 27 units of analysis since two groups of two SMFEs work together as a consortium.

Table 2 Comparison of the means of the indicators of produced capital among private SMFEs in the Tahuamanu, Tambopata, and Manu provinces, Madre de Dios, 2002–2006

Indicators of produced capital	Tahuamanu	Tambopata	Manu	Total	<i>P</i> value (1 versus 2)	<i>P</i> value (1 versus 3)	<i>P</i> value (2 versus 3)
Equipment (\$)	113,940	14,237	6,960	56,124	0.033	0.002	0.431
Roads (\$)	169,083	22,906	2,587	81,100	0.204	0.014	0.340
Harvesting fee (\$)	122,892	88,631	48,477	90,473	0.360	0.041	0.365
Loans (\$)	55,953	7,504	8,189	29,265	0.395	0.253	0.875
Management plans (\$)	42,222	20,380	10,657	26,847	0.076	0.001	0.181
Concession area (ha)	40,595	24,242	18,899	29,729	0.157	0.025	0.542

Bold values indicate statistical significant differences at $P < 0.05$

that define the productive assets they need to pursue their management activities. For purposes of this study, these capitals constitute the main components of SMFE capacity and it is measured in terms of capital accumulated for their first 5 years of operation (corresponding to the harvest period from 2002 to 2006).³ While most data were collected through the survey (Table 1), we obtained additional secondary information from the National Institute of Natural Resources (now the General Directorate of Fauna and Wildlife) on approved and harvested timber volumes of SMFEs. Secondary data were also used to verify reported information on size of concession areas, harvested areas by year, and harvesting fees.

Given the differences in histories of logging and remaining timber stocks among the provinces of Madre de Dios, we pursue a comparative analysis of the capitals and capabilities of private SMFEs across the three provinces. This provides a basis for evaluating SMFE capacities for SFM in portions of Madre de Dios with and without high-value species such as mahogany. More generally, a comparative analysis offers a means of appraising spatial variation in SMFE capacity for SFM. We compare means and proportions for the capitals outlined in Table 1, and employ ANOVA and other tests of means to evaluate the statistical significance of differences. We highlight pairwise comparisons to see which provinces differ from each other in terms of their SMFE capacities.

Results

Produced Capital among Private SMFEs

Table 2 compares produced capital among SMFEs across the three provinces of Madre de Dios. We find that the indicators of equipment, roads, harvesting fees,

³ This period of time is important because it represents the 5 years grace period that the State granted to SMFEs to manage their forests without the elaboration of a current forest inventory of their areas (but using only a governmental study), and within a promotional regime of discounts in the payment of their harvesting fees.

management plans, and concession area exhibit larger values in Tahuamanu than in Tambopata and Manu. However, there are only statistically significant differences ($P < 0.05$) in produced capital among SMFEs in Tahuamanu and Manu, which implies differences in produced capital among SMFEs within provinces.

The value of equipment possessed by SMFEs in Tahuamanu was approximately eight times larger than in Tambopata, and sixteen times larger than in Manu. This large difference is due to the heavy forest equipment (e.g., tractors, band-sawmills, front loaders, etc.) owned by several SMFEs in Tahuamanu—particularly by SMFEs which attained forest certification—in comparison with the light forest equipment (portable sawmills, chainsaws, small boats) mostly owned by the SMFEs in Tambopata and Manu. Although SMFEs in Tahuamanu possess more valuable and durable equipment in comparison to SMFEs in the other two provinces, most of the equipment was old and worn-out; thus most of the equipment in the area only has a low residual value.

With respect to the value of constructed roads, in Tahuamanu this value was sixty-five times the value in Manu, and seven times the value in Tambopata. The higher value of constructed roads in Tahuamanu is due to the fact that most SMFEs there (67%) have terrestrial access to their concessions, thus they had to build and maintain roads in order to harvest timber. We also note that 5 SMFEs in Tahuamanu invested heavily in road construction and maintenance during 2006 as a precondition for certification. In Tambopata and Manu, there was less investment in roads because all SMFEs in Tambopata and many in Manu (78%) are restricted to fluvial transportation to access their concessions.

Concerning the value of the harvesting fee, SMFEs in Tahuamanu exhibit a larger accumulated harvesting fee value than the other two provinces; however, the only statistically significant difference was with Manu. This difference is mainly because of the larger concession areas granted to enterprises in Tahuamanu, which is directly related to the harvesting fee value. Although the baseline harvesting fee established for the bidding process was US\$0.40/ha, the harvesting fee offered by SMFEs in the three provinces was, on average, almost double the baseline fee: US\$0.87/ha in Tahuamanu, US\$0.76/ha in Tambopata, and US\$0.93/ha in Manu. SMFEs bid higher in order to obtain a forest concession, without understanding that harvesting fees are annual payments. This has resulted in several SMFEs having problems in paying their annual harvesting fees. In 2006, only 57% of the SMFEs had paid their total harvesting fees: 67% in Tahuamanu, 50% in Tambopata, and 56% in Manu. Since payment of the harvesting fee is a requirement to transport timber from forest concessions, this finding indicates that only some SMFEs were able to sell their timber in 2006.

Most members of SMFEs have no credit history since most of them were working under short-term contracts (1–2 years) or informally prior to the concession system. As of 2003, the Promotional Fund for Forest Development (FONDEBOS-QUE) was the only institution providing small loans⁴ to SMFEs as seed money for working capital. Since then, banks also provided a few loans to SMFEs. By 2006, 68% of all SMFEs had received some type of loan: 83% in Tambopata, 67% in

⁴ Initial credits were up to US\$2,890 (or 10,000 nuevos soles).

Table 3 Comparison of the means of the indicators of natural capital among private SMFEs in the Tahuamanu, Tambopata, and Manu provinces, Madre de Dios, 2002–2006

Indicators of natural capital	Tahuamanu	Tambopata	Manu	Total	P value (1 versus 2)	P value (1 versus 3)	P value (2 versus 3)
Approved volume (m ³ /ha)	34.54	26.35	35.25	32.96	0.436	0.928	0.416
A volume (m ³ /ha)	2.26	0.79	0.22	1.25	0.034	0.000	0.037
B volume (m ³ /ha)	0.76	1.87	0.88	1.05	0.010	0.849	0.020
C volume (m ³ /ha)	5.35	16.24	20.63	12.86	0.005	0.000	0.429
D volume (m ³ /ha)	14.10	2.94	3.38	8.04	0.000	0.000	0.916
E volume (m ³ /ha)	12.08	4.51	10.14	9.75	0.018	0.419	0.099
Harvested volume (m ³ /ha)	6.34	13.29	24.63	13.98	0.225	0.008	0.225
A volume (m ³ /ha)	1.87	0.79	0.22	1.08	0.093	0.000	0.029
B volume (m ³ /ha)	0.23	1.54	0.60	0.64	0.000	0.228	0.010
C volume (m ³ /ha)	0.56	8.72	16.51	7.69	0.011	0.000	0.132
D volume (m ³ /ha)	2.77	0.85	1.71	1.99	0.365	0.995	0.387
E volume (m ³ /ha)	0.92	1.41	5.58	2.58	0.772	0.007	0.039

Bold values indicate statistical significant differences at $P < 0.05$

Tahuamanu and 56% in Manu. Despite the lower percentage of SMFEs who received loans in Tahuamanu, the total value of the loans received there is seven times greater than in Tambopata and Manu; however, no statistically significant differences appear among the three provinces (Table 2). This is because 25% of the SMFEs in Tahuamanu received large loans (greater than US\$ 300,000).

The main source of formal loans for SMFEs (78%) remains FONDEBOSQUE. Most loans have been small and insufficient for SMFE operations. Consequently, almost all SMFEs have relied on the informal system of *habilito* to finance their harvesting activities.⁵ Although this mechanism usually presents disadvantages to the concessionaire (*habilitado*), they do not have other options since there are few formal financial mechanisms that provide credit to SMFEs.

SMFEs have to file annual operating plans to demonstrate they are fulfilling their forest management obligations. The value of management plans in Tahuamanu is twice as great as in Tambopata, and four times as great as in Manu (Table 2); however, only the latter difference is statistically significant. This difference reflects the larger average annual harvested area in Tahuamanu (1,205 ha) compared to Tambopata (856 ha) and Manu (477 ha). The higher value in management plans in Tahuamanu also exists because there are more concession contracts and, as a consequence, more annual operating plans were presented in Tahuamanu than in the other provinces. Finally, SMFEs from Tahuamanu exceeded the other two provinces

⁵ In the *habilito* system, the *habilitador* (i.e., timber buyer) gives some money in advance to the *habilitado* (in this case the concessionaire) for a determined volume of timber. Once the timber is harvested, the *habilitado* has to sell all the harvested timber to the *habilitador* for a price determined by the *habilitador*, which is usually below market price. Also, in this system, the *habilitador* usually finds “defects” in the timber in order to under value the timber extracted and pay less.

with respect to forest concession areas. Areas in Tahuamanu's SMFEs were approximately twice as large as concessions in Tambopata and Manu; however, they were significantly different only when compared to Manu. Differences in concession area size were noticeable right from the beginning of the bidding process in Madre de Dios, due to the greater availability of harvesting units⁶ in Tahuamanu (92 units) than in Tambopata (32 units) and Manu (43 units).

Natural Capital among Private SMFEs

Table 3 presents data for the natural capital of SMFEs. Comparing the two indicators of natural capital (in terms of five categories of timber species differentiated according to their commercial value) among the three provinces, we find that significant differences exist in the approved volumes for mahogany (category A), as well as cedar (category B), and timber species in categories C, D, and E.

The presence of mahogany, the most valuable timber species in the country,⁷ was three times greater among SMFEs in Tahuamanu than in Tambopata, and ten times greater than in Manu. This is a reflection of historical timber activity in Madre de Dios, where Tahuamanu has been the least harvested province. With respect to the presence of cedar (category B), the second most valuable species in the country, SMFEs in Tambopata have almost double the approved volume of cedar than SMFEs in the other two provinces; these differences are statistically significant. Loggers in Tambopata had selectively exploited both mahogany and cedar, though there still remains some cedar (IIAP and CTAR-Madre de Dios 2001).

Regarding approved volumes of less valuable commercial timber species (categories C, D, and E), SMFEs in Manu and Tambopata exhibit larger volumes of species of category C than in Tahuamanu; these differences are also statistically significant. In contrast, however, the volumes of D category species in Tahuamanu's SMFEs were significantly larger than in the other two provinces, as were the volumes of category E species with regard to the SMFEs in Tambopata. Manu province has been characterized by a scarcity of valuable commercial tree species due to previous timber harvesting (IIAP and CTAR-Madre de Dios 2001). Thus, the forest concessions in this area were characterized by the presence of lower-priced and lesser-known timber species. In this situation, SMFEs compensate for low value by increasing volume, which explains the larger volumes of timber harvested by SMFEs in Manu.

In Manu, SMFEs harvested 70% of their total approved volume for the period under study. From this volume, 67% correspond to timber species of C category (which have intermediate commercial value and are the most abundant in the province), and 23% to species of E category. Although species of E category include many lesser known timber species, and are the least valuable in comparison to the

⁶ Harvesting units are the units in which the permanent production forests were divided. Each unit comprises areas between 5,000–10,000 ha.

⁷ In 2006, the average price of mahogany was 2.8 US\$/board feet in comparison to 1.1 US\$/board feet for cedar, and 0.4 US\$/board feet for *tornillo* (the second and third most valuable species in the country).

other categories, since 2004 several of these species started having demand in the market, including *Hymenaea* sp., *Myroxylon balsamum*, and *Aspidosperma macrocarpon*. In Tambopata, 50% of the total approved volume has been harvested; cedar comprised up to 11.5% of the total volume actually harvested and timber species of C category comprised up to 65.6% of this volume.

In Tahuamanu, the situation is completely different. There, SMFEs only harvested 18% of their total approved volume; this is because of the presence of the valuable mahogany which comprised up to 29% of the total volume harvested. In addition, species of D category (especially *Dipteryx odorata*) made up to 43% of the total volume harvested there.

Human Capital among Private SMFEs

Comparisons of human capital indicators among the three provinces appear in Table 4. We found no statistically significant differences among pairs of province means, and therefore, present only the *P* values for the overall ANOVA. While provincial differences were not important, there was variation among SMFEs within provinces, so it is nonetheless important to characterize the human capital of SMFEs in Madre de Dios.

Most SMFEs in this study were constituted in 2002, and were formed as associations called *Sociedades Anónimas Cerradas* (67% in Tahuamanu and Tambopata, and 78% in Manu). Such associations allow up to 20 members and divide the capital of the enterprise by shares. Associations constituted a means for small loggers to pool their individually limited capital to form a more viable enterprise. However, associations also created disadvantages for several SMFEs due to disagreements and misunderstandings among members. This caused divisions among members and affected the operations and management of SMFEs and their concessions. For example, in 2006, less than 5 years after SMFEs were constituted, there was a reduction in the number of members per enterprise. Among SMFEs in Tahuamanu, 42% had reductions and in these enterprises the number of members decreased by 50%, while in Tambopata only 17% of the SMFEs had experienced a decrease (averaging 33%) in their initial membership. In Manu, 44% of SMFEs experienced a reduction in their initial membership (averaging 37%); however, the SMFEs there still had a larger number of members than in the other two provinces.

At the same time, SMFEs have obtained external assistance to build their human capital in terms of technical capacity. With the new forest regime, concessionaires

Table 4 Comparison of the means of the indicators of human capital among private SMFEs in the Tahuamanu, Tambopata, and Manu provinces, Madre de Dios, 2002–2006

Indicators of human capital	Tahuamanu	Tambopata	Manu	Total	<i>P</i> value (overall)
Number of members	7.42	4.83	10.33	7.81	0.187
Logging experience (Members)	7.00	3.83	4.33	5.41	0.358
Business experience (Members)	7.00	4.17	4.33	5.48	0.377
Manager education (Years)	12.50	11.00	10.56	11.52	0.404

Table 5 Comparison of the means of the indicators of social capital among private SMFEs in the Tahuamanu, Tambopata, and Manu provinces, Madre de Dios, 2002–2006

Indicators of social capital	Tahuamanu	Tambopata	Manu	Total	P value (overall)
Association density (Number)	0.58	1.17	0.11	0.56	0.015
Network assistance (%)	53.96	60.32	53.94	55.37	0.767
Exclusion (%)	36.90	16.67	25.40	28.57	0.516
Member trust (%)	73.61	79.87	73.61	75.00	0.793
Member participation (%)	80.75	79.47	74.33	78.33	0.605

Bold value indicates statistical significant difference at $P < 0.05$

have been exposed to the concept of forest management (versus the simpler timber extraction) with its greater technical demands. With assistance from environmental NGOs such as World Wildlife Fund (WWF), *Fundación Peruana para la Conservación de la Naturaleza* (ProNaturaleza), and Cooperazione e Sviluppo (CESVI),⁸ concessionaires started learning the basics of forest management and business. This included how to conduct a forest inventory, how to harvest species using reduced impact techniques, and the basics of business management and marketing.

Among SMFE employees, managers have the highest level of education, but their formal educational attainment was limited. SMFE managers in Tahuamanu had on average 2 years of post-secondary technical studies, while in Tambopata, SMFE managers had completed their secondary studies, and in Manu, SMFE managers only averaged 4 years of secondary schooling. Another issue is the low level of education and technical skills of many workers, which are usually temporarily hired by SMFEs.

Members of most SMFEs in Tahuamanu and Tambopata had some previous experience in logging and other business activities (91 and 89%, respectively). Prior experience in logging came mainly from informal activities. Consequently, most SMFE knowledge of logging was limited to the selective extraction of mahogany and cedar. In Manu, however, members of relatively few SMFEs (44%) had previous logging and business experience, less than the other two provinces. The main motivation for people in Manu to organize themselves into SMFEs and apply for a forest concession was to avoid allowing outsiders to occupy the forests of the province. People in Manu applied to the public bidding in order to preserve their use rights to forested land for their subsistence.

Social Capital among Private SMFEs

Comparing indicators of social capital (Table 5), we find similar characteristics among SMFEs in the three provinces with respect to their member participation in enterprise activities, the extent to which enterprise members trust each other, and exclusion among enterprise members. The only statistically significant difference

⁸ Other institutions such as the *Cámaras Forestal Nacional*, FONDEBOSQUE, and ITTO conducted some workshops on issues related to forest management for all concessionaires.

occurs in density of membership in forest associations among SMFEs in Tambopata and Manu.

In Tambopata, 83% of the SMFEs belong to 1 or 2 forest associations, while 17% do not belong to any association. The main forest association in Tambopata is the *Asociación de Concesionarios de Madre de Dios* (ACOMAD), which was formed in 2002 as a way for new concessionaires to have representation and to look for solutions to common problems. The other association is the *Comité de Gestión de Bosques del Río Las Piedras*, a multi-stakeholder organization formed in 2005 with the goal of monitoring and promoting forest management activities in the watershed of the Las Piedras River. In Tahuamanu, 58% of the SMFEs do not belong to any forest association, while 42% belong to one or two forest associations: the *Asociación de Concesionarios Forestales de Tahuamanu*⁹ and the *Comité de Gestión de Bosques del Río Tahuamanu*. In contrast to the other two provinces, in Manu, 89% of the SMFEs do not belong to any association. SMFEs in Manu formed a forest association in 2003 but this association did not last. Consequently, 11% of SMFEs in Manu became members of the ACOMAD. Distance and costs in transportation from Manu to Puerto Maldonado, where the ACOMAD holds its meetings, have kept more SMFEs in Manu from joining this association.

Discussion

The results show that SMFEs in Madre de Dios exhibit varying capacities for forest management among as well as within provinces. Between-province variation is especially pronounced for produced and natural capitals. In contrast, there is not much variation in SMFE capacities among the three provinces of Madre de Dios in terms of their human and social capital assets. However, the findings also indicate that most SMFEs in Madre de Dios exhibit limited capacity for SFM. This conclusion bears several implications, which we discuss by following the organization of our capital framework, beginning with produced capital and concluding with social capital. In each instance, we focus on the implications for SMFE viability as an institutional model for SFM.

Access to financial resources is one of the major limitations to the effective operation of SMFEs in many countries (Auren and Krassowska 2004). In Madre de Dios, most small entrepreneurs have limited financial resources, and there is a lack of adequate formal sources of financing for the forest sector. This is because logging in the Amazon is considered a risky activity due to the seasonal nature of logging, and because most SMFEs do not have a credit history, business experience, or collateral. Bank loans carry high interest rates which are prohibitive for most start-up SMFEs; thus most SMFEs cannot access and/or afford these credits because of their low profit margins (Lewis et al. 2004). Although formal funding was provided to some SMFEs, the credit was too limited and short-term, and thus insufficient for SMFEs just beginning their operations. Thus, almost all SMFEs in Madre de Dios

⁹ This association emerged in 2004 as a way for SMFEs from the Tahuamanu province to have their own representation and with the goal of finding solutions to their problems.

have relied on informal financial arrangements to finance their harvesting activities, suffering disadvantages in sale prices and negotiating leverage. These financial constraints are not unique to SMFEs in Madre de Dios; they apply elsewhere in Peru (Arce 2006), and even among relatively successful SMFEs in Bolivia, Brazil, Colombia, and Ecuador (Tomaselli and Tuoto 2004).

A key consequence of the predominance of informal financial systems concerns the restricted operational capacity of SMFEs. For example, limited financial resources have reduced the opportunities for SMFEs to invest in better equipment. Limited investment in technology has in turn led to selling round-wood at lower prices because most SMFEs lack equipment for value-added processing; another consequence is the large amount of wasted timber (Vásquez 2007). Inadequate technology has been a generalized characteristic among small and medium-sized loggers in the Peruvian Amazon for several decades (Chirinos and Ruíz 2003). It is also a common characteristic in countries like Guyana, Uganda, and South Africa (Thomas et al. 2003; Auren and Krassowska 2004; Lewis et al. 2004).

Financial constraints also reduce the opportunities for SMFEs to fulfill their management obligations. Relatively few SMFEs in Madre de Dios (43%) have been able to pay their total harvesting fees through the 2006 harvest, despite discounts offered by INRENA in the first year of concession contracts. Since payment of the harvesting fee is a requirement for selling timber, most SMFEs are unable to transport their harvest from their concessions. SMFEs must therefore, choose to either incur losses or engage in illegal sales of timber transportation permits.

With regard to natural capital, timber species and volumes in forest concessions are significant factors for SMFE viability. Mahogany, cedar, and *tornillo* have traditionally been the most valuable species in the country. However, mahogany and cedar have been over-exploited in Madre de Dios, especially in Manu (IIAP and CTAR-Madre de Dios 2001). Consequently, SMFEs in Manu are characterized by the presence of lower priced timber species. This limitation has resulted in the harvesting of larger timber volumes, and carries the consequences of reducing the financial possibilities for SMFEs in Manu to invest in equipment, to fulfill their obligations in paying their total harvesting fees, and to carry out their annual harvests on time.

In contrast, availability of mahogany affords advantages to SMFEs in Tahuamanu, not only because of its high value, but also because mahogany is readily convertible into cash (CESVI 2005). For SMFEs in Tahuamanu, mahogany became the main source of financing for short-term activities and a strategic tool in the process of capitalization. Indeed, if the price of mahogany had been lower, many SMFEs in Tahuamanu would have become bankrupt (CESVI 2005). The presence of mahogany provided SMFEs with financial advantages that resulted in the fulfillment of their operational obligations and investments in better equipment. As a result, SMFEs with greater natural capital in the form of mahogany have proven to be better off. Moreover, the SMFEs of Tahuamanu with the highest volumes of mahogany have been able to attain forest certification; these SMFEs also received financial assistance from NGOs for actions required to improve forest management and for the evaluation process.

The presence of mahogany has also been key to La Chonta, a private SMFE in Bolivia. However, mahogany became rare, forcing La Chonta to diversify to lesser-known species (Tomaselli and Tuoto 2004). It is likely that SMFEs in Tahuamanu will eventually have to transition to lesser-known species in order to maintain their economic viability. Putzel (2009) indicates that this process has started in Madre de Dios due to new demand from the Chinese market; this should help those SMFEs willing and able to harvest lesser-known species. However, SMFEs in Madre de Dios will still face technological challenges as they increasingly rely on harvesting of lesser-known species.

Concerning human capital, the level of technical skill and experience for forest management tends to be low among SMFEs (Auren and Krassowska 2004). Only with the formation of SMFEs have concessionaires in Madre de Dios been exposed to the concepts of forest and business management. Formal training has been limited to a few SMFEs via assistance by NGOs. However, NGO assistance has not been sustained, and there has not been follow-up training after the NGO assistance ended. The training provided to SMFEs has also been mainly in technical aspects of forest management. Other training is also necessary, especially in areas related to enterprise organization and management. Managers of SMFEs in Madre de Dios did not have the skills and capacity to prepare management and business plans, nor did they realize the importance in keeping financial records. Given their limited human capital and the management challenges they face, SMFEs in Madre de Dios need more external support in building their skills and capacities in order to have better opportunities for survival and development.

Finally, social capital is also important among SMFEs because cooperation within SMFEs can contribute to better forest management and enterprise performance (Grootaert and Bastelaer 2002). However, organization and networking among SMFEs are typically poor, which restricts opportunities for effective operation (Auren and Krassowska 2004). In Madre de Dios, most SMFEs exhibit limited coordination, particularly during the first 3 years of enterprise operation, when SMFE members tended to operate as individuals. Limited coordination resulted in competition among members and mutual distrust, which generated internal conflicts and weakened some SMFEs. In many cases, these problems resulted in exclusion of members and thus account for the decline in enterprise membership. Limited coordination also hampered SMFEs in paying their harvesting fees on time because of disagreements among members over the amount necessary to fulfill their respective responsibilities. As a consequence, many SMFEs engaged in illegal actions, such as harvesting larger volumes or additional species beyond those in the management plan, or the sale of transportation permits to ‘legalize’ timber harvested illegally. In addition, failure of SMFEs to better organize themselves has restricted their opportunities to seek outside assistance. Lack of effective organization has reduced SMFE benefits via advocacy and lobbying (Auren and Krassowska 2004). Limited coordination within SMFEs in Madre de Dios hampered opportunities to receive assistance from NGOs. Moreover, networking among SMFEs in Madre de Dios is poor, which places SMFEs at a disadvantage when negotiating credit. Indeed, the main social network for SMFEs is constituted by informal creditors (*habilitadores*) who dominate patronage

relationships precisely because they are well-organized and because SMFEs lack alternative credit sources.

The forest concession regime in Peru, as a system for responsible forest management, is still in the initial phase of development. Although it has captured the interest of many small loggers, it demands more responsibilities by the new concessionaires and their private SMFEs that are not easy to uphold. This is especially true due to decades of disorder and over-exploitation of forest resources, limited capacity of most SMFEs, limited interest and investment by the State in the forest sector, and temporary support by environmental NGOs in sustainable forest management in Peru. It is therefore, important to establish mechanisms for consistent assistance to SMFEs in order to complement logging experience with greater management knowledge. The findings from our analysis suggest that SMFEs have varying capacities and that many have insufficient capacity for SFM. The findings also show that many SMFEs require external support, notably in the forms of credit, technical assistance for forest management and business management, and capacity building for collaboration and SFM. While some SMFEs have adequate capacity, they often rely heavily on their natural capital assets that must be managed carefully to avoid scarcity of high-value timber. Without external support, it will be difficult for SMFEs to realize their potential to reconcile development via employment generation with conservation via SFM.

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